

Polypharmacy With Oral Antidiabetic Agents: An Indicator of Poor Glycemic Control

Cynthia J. Willey, PhD; Susan E. Andrade, ScD; Joseph Cohen, MD;
Jackie C. Fuller, MPH; and Jerry H. Gurwitz, MD

Objective: To evaluate antidiabetic drug treatment patterns and glycemic control among patients diagnosed with type 2 diabetes mellitus.

Study Design: Retrospective study using the automated databases of a 200 000-member HMO.

Methods: The study population consisted of patients ≥ 18 years of age with documented type 2 diabetes mellitus from January 1, 2002, through December 31, 2002. We determined the proportion of patients who had optimal glycemic control (glycosylated hemoglobin $< 7\%$) during the 6 months after the initial documentation of diabetes during calendar year 2002 (index date).

Results: Of the 4282 patients who met the inclusion criteria, 1050 (25%) received 1 oral agent, 486 (11%) received 2 oral agents, 56 (1%) received ≥ 3 oral agents, 84 (2%) received insulin and an oral agent, and 107 (2%) received insulin exclusively within 90 days after the index date. Among the 1075 patients receiving antidiabetic drug therapy who had a laboratory test result documented, 414 (39%) had optimal glycemic control. Optimal control was most frequent among patients receiving 1 oral agent (47%) and least frequent among patients receiving ≥ 3 oral agents (13%) ($P < .01$). Patients with a prior history of suboptimal glycemic control were less likely to have optimal glycemic control.

Conclusions: Multiple oral antidiabetic agents may serve as a marker for more severe, uncontrolled diabetes. The vast majority of patients treated with multiple oral antidiabetic agents had suboptimal glycemic control, suggesting a need for intensified efforts to treat this particular group of patients to recommended goal levels.

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Diabetes mellitus is a major cause of morbidity and mortality worldwide. The number of Americans with diagnosed diabetes is projected to increase 165% from 11 million in 2000 to 29 million in 2050,¹ resulting in a large number of patients requiring lifetime treatment with antidiabetic agents or insulin. Diabetes presents an enormous economic burden to the United States. Direct medical expenditures attributable to diabetes totaled approximately \$92 billion in 2002; more than 25% of the expenditures were attributable to treating diabetes-related complications.²

Optimal glycemic control is critical for reducing the risk of diabetic complications. The Diabetes Control and Complications Trial and the UK Prospective Diabetes Study (UKPDS) provided evidence of the relationship

between hyperglycemia and long-term diabetic complications.^{3,4} The UKPDS study provided strong evidence that intensive therapy significantly reduced the risk of microvascular complications in patients with type 2 diabetes. The American Diabetes Association recommends treating diabetic patients to a glycosylated hemoglobin (A1C) level of less than 7%.⁵ However, the majority of diabetes patients still do not achieve recommended target values.^{6,7} A preliminary report based on National Health and Nutrition Examination Survey (NHANES) data found that the rate of glycemic control (as defined by an A1C level of $< 7\%$) declined from 44.5% in NHANES III (1988-1994) to 35.8% in NHANES 1999-2000⁶; however, the NHANES 1999-2000 data were based on a small number of diabetes patients ($n = 372$). Another study among patients included in the Kaiser Permanente Northern California Diabetes Registry similarly reported low rates of glycemic control, with 30% of the diabetic population having an A1C level of 7% or less from 1999 through 2000.⁷ Rates of healthcare access and utilization, screening for diabetes complications, and the rate of treatment of hyperglycemia are high; however, health status and outcomes are unsatisfactory. There are likely to be multiple reasons for this discordance, including intractability of diabetes to current therapies, patient self-care practices, and medical care practices.⁸

The newer medications introduced during the past decade provide additional options for treating patients with type 2 diabetes. The availability of many new options may have a large impact on current antidiabetic therapy patterns and the rates of glycemic control. We undertook the present study to document current treatment patterns and glycemic control among patients with type 2 diabetes in a large, population-based sample.

From Meyers Primary Care Institute, Worcester, Mass (CJW, SEA, JC, JCF, JHG); and the College of Pharmacy, University of Rhode Island, Kingston, RI (CJW).

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Address correspondence to: Susan E. Andrade, ScD, Meyers Primary Care Institute, 630 Plantation St, Worcester, MA 01605. E-mail: sandrade@meayersprimary.org.

METHODS**Study Population and Design**

A retrospective study was conducted among patients enrolled in a mixed-model, not-for-profit HMO operating in New England. The study population included HMO members who were 18 years of age or older and who had a diagnosis code for type 2 diabetes mellitus (*International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] 250.x0 or 250.x2) from January 1, 2002, through December 31, 2002, as documented in the HMO administrative databases. Additional eligibility criteria included continuous enrollment in the staff-model component with prescription drug coverage for the 365 days before and 180 days after the initial documentation of diabetes (index date) during calendar year 2002. Members with a diagnosis code for gestational diabetes (ICD-9-CM 648) or type 1 diabetes mellitus (ICD-9-CM 250.x1 or 250.x3) were excluded from the study. Information on patient sex and age, health plan enrollment status, prescription drug dispensings, inpatient and outpatient diagnoses and procedures, and laboratory test results was obtained from HMO automated databases for the period 365 days before and 180 days after the index date. The institution's human-subjects committee reviewed and approved the study.

Identification and Categorization of Antidiabetic Drug Use

For each patient, antidiabetic medications dispensed during the 90 days after the index date were identified, and therapy was classified according to the total number of unique agents dispensed, based on the agents' generic names. Therapy was categorized as "1 oral agent," "2 oral agents," "3 or more oral agents," "insulin plus an oral agent," "insulin use exclusively," or "no antidiabetic medications."

Assessment of Glycemic Control

The HMO automated databases were used to identify the patients' current and prior history of glycemic control. Current optimal glycemic control was determined using the most recent laboratory test result for A1C during the 6 months (180 days) after the index date and was defined as an A1C level of less than 7% during the 6 months after the index date. Similarly, prior history of glycemic control was determined by using the most recent laboratory test result for A1C during the year (365 days) before the index date.

Identification and Definition of Other Patient Characteristics

The HMO automated databases were used to identify

the patients' age on the index date; sex; antidiabetic drug therapy during the 90 days before the index date (categorized as outlined above); diagnosis of coronary heart disease (ICD-9-CM 410 to 414.99), hypertension (ICD-9-CM 401.x), or hypercholesterolemia (ICD-9-CM 272.x or dispensing of a cholesterol-lowering drug) during the previous year; utilization of health services; medication adherence; and comorbidity score. The total numbers of ambulatory visits, diabetes-related ambulatory visits (office visits including ICD-9-CM code 250.x1 or 250.x3), and hospitalizations during the previous year were determined.

Medication adherence during the year before the index date was estimated based on the supply dispensed (in days) from the first dispensing date of an oral antidiabetic drug during the previous year to the index date, divided by the number of days between the first dispensing date and the index date (percent days on therapy). If 1 prescription was dispensed during the time interval of a previous prescription, the overlapping number of days, supply was not duplicated.

Comorbidity was assessed using the chronic disease score developed by Clark and colleagues for prediction of healthcare costs, which is based on age, sex, and number of dispensings of prescription drugs.⁹ The chronic disease score is a claims-based, risk-adjustment metric that uses drug-dispensing information as a marker for chronic illness. The scores have been found to be predictive of utilization of healthcare resources, with higher scores reflecting higher healthcare costs. The scores also have been found to be predictive of hospitalization.¹⁰

Statistical Analysis

Descriptive analyses were used to estimate the proportion of patients to whom each type of antidiabetic drug therapy was dispensed and the proportion who had specific characteristics. For patients receiving antidiabetic medications who had a laboratory test value documented in the 6 months after the index date, the percentage with optimal glycemic control was estimated overall and according to patient characteristics. Logistic regression was used to estimate the strength of the association between patient characteristics and optimal glycemic control, with models constructed including variables for patient age; sex; antidiabetic drug therapy; past history of glycemic control; diagnosis of coronary heart disease, hypertension, or hypercholesterolemia; prior hospitalization; diabetes-related office visits during the previous year; medication adherence; and chronic disease score. Analyses of glycemic control based on an A1C value of less than 8% also were performed, but are not presented; the associations between

glycemic control and patient characteristics were similar to those results based on an A1C value of less than 7%.

RESULTS

A total of 4282 members who were diagnosed with type 2 diabetes mellitus met the inclusion criteria. The mean age of the study population was 64 years (range, 20-96 years) and 46% (n = 1951) were female. Characteristics of the study population are shown in **Table 1**. During the 90 days after the index date, 1050 patients (25%) received 1 oral agent, 486 (11%) received 2 oral agents, 56 (1%) received 3 or more oral agents, 84 (2%) received insulin and an oral agent, 107 (2%) received insulin exclusively, and 2499 (58%) received no antidiabetic medications. The most common medications dispensed to patients taking 2 oral agents were a sulfonylurea and metformin (428 patients), and the most common medications dispensed to patients taking 3 or more agents were a sulfonylurea, metformin, and a thiazolidinedione (52 patients).

Of the 4282 study patients, 1072 (25%) had an A1C level of less than 7% (optimal glycemic control), and 155 (4%) had an A1C level of 9% or higher. A total of 1873 patients had an A1C value documented in the 6 months after the index date. Of this group, 1075 also were receiving antidiabetic drug therapy; 414 (39%) of these patients had optimal glycemic control. The mean A1C value was 7.4%, and the median value was 7.2% (25th-75th percentile, 6.6%-8.1%). The mean A1C ranged from 7.2% among patients receiving 1 oral agent to 8.0% among patients receiving 3 or more oral agents ($P < .001$). **Table 2** shows the number and percentage of patients with optimal glycemic control according to patient characteristics, as well as the odds ratios (ORs) and 95% confidence intervals (CIs) for the associations with optimal glycemic control. The proportion of patients with optimal control was highest among those receiving 1 oral agent (47%) and lowest among those receiving 3 or more oral agents (13%) ($P < .01$). Patients with a prior history of suboptimal glycemic control were less likely than patients whose A1C level was less than 7% to have optimal glycemic con-

Table 1. Characteristics of Patients Diagnosed With Type 2 Diabetes Mellitus (N = 4282)

Characteristic	No. (%)
Sex	
Female	1951 (46)
Male	2331 (54)
Age, y	
18-44	380 (9)
45-54	760 (18)
55-64	1020 (24)
65-74	1045 (24)
≥75	1077 (25)
Antidiabetic therapy within 90 days after the index date*	
One oral agent	1050 (25)
Sulfonylurea	804
Metformin	230
Thiazolidinedione	16
Two oral agents	486 (11)
Sulfonylurea plus metformin	428
Sulfonylurea plus thiazolidinedione	41
Sulfonylurea plus α -glucosidase inhibitor	2
Sulfonylurea plus sulfonylurea	1
Metformin plus thiazolidinedione	13
Metformin plus meglitinide	1
Three oral agents	56 (1)
Sulfonylurea, metformin, thiazolidinedione	52
Two sulfonylureas plus metformin	3
Metformin plus 2 thiazolidinediones	1
Insulin plus an oral agent	84 (2)
Insulin plus sulfonylurea	8
Insulin plus metformin	42
Insulin plus thiazolidinedione	7
Insulin plus combination of oral agents	27
Insulin exclusively	107 (2)
No antidiabetic medications	2499 (58)
Current glycemic control (A1C level), %[†]	
<7	1072 (25)
7 to <8	444 (10)
8 to <9	202 (5)
≥9	155 (4)
No A1C measurement within 6 mo after index date	2409 (56)
Concomitant diagnosis	
Coronary heart disease	695 (16)
Hypertension	2425 (57)
Hypercholesterolemia	2407 (56)
Utilization of services in previous year	
Number of overall ambulatory visits	
0-2	1157 (27)
3-4	1041 (24)
5-7	1006 (23)
≥8	1078 (25)
Number of diabetes-related office visits [‡]	
0-1	971 (23)
2-3	1476 (34)
4-5	834 (19)
≥6	1001 (23)
Hospitalization (1 or more in previous year)	
Yes	532 (12)
No	3750 (88)
Total costs by chronic disease score quintile,[§] \$	
0-1401 (quintile 1)	857 (20)
>1401-2111 (quintile 2)	855 (20)
>2111-2816 (quintile 3)	858 (20)
>2816-3820 (quintile 4)	856 (20)
>3820 (quintile 5)	856 (20)

*The index date was the first documentation of type 2 diabetes during 2002.

[†]The A1C level was measured within 180 days after the index date.

[‡]Diabetes-related office visits were those with a diagnosis code of type 2 diabetes mellitus (*International Classification of Diseases, Ninth Revision, Clinical Modification* code 250.x0 or 250.x2).

A1C indicates glycosylated hemoglobin.

Table 2. Proportion of Patients With Optimal Glycemic Control Among Those Receiving Antidiabetic Medications (N = 1075)*

Characteristic	No. (%) of Patients With Optimal Glycemic Control	Unadjusted Odds Ratio (95% CI)	Adjusted Odds Ratio (95% CI) [†]
Antidiabetic drug therapy[‡]			
One oral agent (n = 600)	284 (47)	1.0 (reference)	1.0 (reference)
Two oral agents (n = 308)	91 (30)	0.47 (0.35, 0.63)	0.53 (0.38, 0.76)
Three oral agents (n = 45)	6 (13)	0.17 (0.07, 0.41)	0.20 (0.08, 0.54)
Insulin plus oral agent (n = 62)	16 (26)	0.39 (0.21, 0.70)	0.50 (0.24, 1.01)
Insulin exclusively (n = 60)	17 (28)	0.44 (0.25, 0.79)	1.14 (0.49, 2.63)
Sex			
Female (n = 461)	187 (41)	1.16 (0.91, 1.49)	1.07 (0.79, 1.45)
Male (n = 614)	227 (37)	1.0 (reference)	1.0 (reference)
Age, y			
18-44 (n = 84)	30 (36)	1.0 (reference)	1.0 (reference)
45-54 (n = 222)	69 (31)	0.81 (0.48, 1.38)	0.74 (0.40, 1.37)
55-64 (n = 309)	102 (33)	0.89 (0.54, 1.47)	0.76 (0.41, 1.39)
65-74 (n = 235)	101 (43)	1.36 (0.81, 2.27)	0.81 (0.42, 1.56)
≥75 (n = 225)	112 (50)	1.78 (1.06, 2.99)	0.81 (0.41, 1.61)
Prior history of glycemic control (A1C level), %[§]			
<7 (n = 442)	294 (67)	1.0 (reference)	1.0 (reference)
7 to <8 (n = 275)	62 (23)	0.15 (0.10, 0.21)	0.15 (0.11, 0.22)
8 to <9 (n = 141)	18 (13)	0.07 (0.04, 0.13)	0.08 (0.05, 0.14)
≥9 (n = 120)	14 (12)	0.07 (0.04, 0.12)	0.08 (0.04, 0.15)
No A1C measurement during the previous year (n = 97)	26 (27)	0.18 (0.11, 0.30)	0.20 (0.12, 0.34)
Concomitant diagnosis			
Coronary heart disease			
Yes (n = 157)	60 (38)	0.99 (0.70, 1.40)	0.88 (0.55, 1.39)
No (n = 918)	354 (39)	1.0 (reference)	1.0 (reference)
Hypertension			
Yes (n = 614)	250 (41)	1.24 (0.97, 1.60)	1.00 (0.73, 1.36)
No (n = 461)	164 (36)	1.0 (reference)	1.0 (reference)
Hypercholesterolemia			
Yes (n = 595)	232 (39)	1.05 (0.82, 1.34)	1.09 (0.80, 1.48)
No (n = 480)	182 (38)	1.0 (reference)	1.0 (reference)
Utilization of services in previous year			
Number of diabetes-related office visits			
0-1 (n = 170)	57 (34)	1.0 (reference)	1.0 (reference)
2-3 (n = 401)	166 (41)	1.40 (0.96, 2.04)	1.39 (0.89, 2.17)
4-5 (n = 212)	84 (40)	1.30 (0.85, 1.98)	1.26 (0.76, 2.09)
≥6 (n = 292)	107 (37)	1.15 (0.77, 1.71)	1.31 (0.81, 2.13)
Hospitalization (1 or more in previous year)			
Yes (n = 137)	60 (44)	1.29 (0.90, 1.85)	0.88 (0.54, 1.42)
No (n = 938)	354 (38)	1.0 (reference)	1.0 (reference)
Medication adherence in prior year (% days on therapy)			
0% to <50% (n = 267)	112 (42)	1.0 (reference)	1.0 (reference)
50% to <70% (n = 223)	91 (41)	0.95 (0.67, 1.37)	1.28 (0.83, 1.97)
70% to <90% (n = 206)	78 (38)	0.84 (0.58, 1.22)	1.49 (0.94, 2.34)
≥90% (n = 273)	107 (39)	0.89 (0.63, 1.26)	1.64 (1.07, 2.52)
Not evaluated: no dispensings in prior year (n = 106)	26 (25)	0.45 (0.27, 0.75)	0.61 (0.30, 1.24)
Chronic disease score			
Quintile 1 or 2 (n = 262)	76 (29)	1.0 (reference)	1.0 (reference)
Quintile 3 (n = 228)	86 (38)	1.48 (1.02, 2.16)	1.21 (0.76, 1.92)
Quintile 4 (n = 287)	123 (43)	1.84 (1.29, 2.62)	1.39 (0.86, 2.26)
Quintile 5 (n = 298)	129 (43)	1.87 (1.31, 2.66)	1.44 (0.86, 2.40)

*Optimal glycemic control was defined as an A1C level of less than 7% within 6 months after the index date (the first documentation of type 2 diabetes mellitus during 2002), among patients for whom an antidiabetic medication was dispensed.

[†]Adjusted relative risk estimates and 95% confidence intervals were determined from multivariate logistic regression models including all variables shown in the table.

[‡]This therapy included antidiabetic drugs dispensed within 3 months after the index date (first documentation of type 2 diabetes mellitus during 2002).

[§]Values represent the A1C levels in the 365 days before the index date.

^{||}Quintiles were based on the distribution in the overall population of patients with documentation of type 2 diabetes mellitus who were eligible for study. A1C indicates glycosylated hemoglobin; CI, confidence interval.

trol (adjusted OR = 0.08, 95% CI = 0.05, 0.14, for those whose A1C level was $\geq 8\%$ to $< 9\%$; adjusted OR = 0.08, 95% CI = 0.04, 0.15, for those whose A1C level was $\geq 9\%$).

Of the 661 patients with poor glycemic control during the 6 months after the index date, 442 (67%) also had poor glycemic control during the 365 days before the index date, 148 (22%) had optimal glycemic control, and 71 (11%) had no A1C test performed during the 365 days before the index date. Most patients with poor glycemic control in both the 6 months after the index date and 1 year previous to the index date received similar antidiabetic drug therapy in the 90 days both before and after the index date; 21 of 30 (70%) received 3 oral agents, 107 of 157 (68%) received 2 oral agents, and 145 of 186 (78%) received 1 oral agent in both 90-day periods. Most patients with poor glycemic control also received similar therapy during each of the 90-day periods from 90 days before the index date through 180 days after the index date, with 17 of 30 (57%) patients receiving 3 oral agents, 93 of 157 (59%) patients receiving 2 oral agents, and 114 of 186 (61%) patients receiving 1 oral agent throughout this period.

DISCUSSION

Treatment regimens among US adults diagnosed with type 2 diabetes have changed substantially in recent years as insulin use declined and use of oral agents increased.^{6,11} However, a decrease in rates of glycemic control also was observed during this time period.⁶ Similar to the findings in other populations,^{6,7} the majority of patients diagnosed with type 2 diabetes in our study population had suboptimal control. This trend may contribute to increased rates of diabetic complications and increased healthcare costs. Knowledge about the variables associated with poor glycemic control is necessary for informing efforts aimed at reversing this trend.

We identified several strong predictors of poor glycemic control, including intensification of therapy, as indicated by treatment with multiple oral agents, and previous suboptimal glycemic control. The association between these variables and poor glycemic control indicates that poor glycemic control tends to persist over time, and that use of more oral medications is not associated with better control, but rather is a marker for a greater likelihood of poor control (ie, patients who are less likely to achieve glycemic control). Benoit and colleagues reported similar results in a recent study of a large sample of patients with type 2 diabetes in a low-income, minority community.¹² Poorer glycemic control was associated with being uninsured, having diabetes for a longer period of time, using multiple oral agents or

insulin, or having high cholesterol. Our results suggest that poor adherence to medications in the prior year was associated with current suboptimal glycemic control, after controlling for other patient characteristics. In previous work we found that although poorer adherence was associated with therapeutic intensification, this finding was largely driven by observed increases in dosage, rather than the addition of oral antidiabetic medications.¹³

Antidiabetic drug therapy during the 90 days before and after the index date among patients with poor glycemic control (n = 442) was relatively stable. Over three quarters (78%) of patients with poor glycemic control who were prescribed 1 oral medication within 90 days after the index date were prescribed 1 medication within 90 days before the index date. Similar percentages were observed for patients prescribed 2 medications (68%) and 3 medications (70%) within 90 days after the index date. Although a number of recent studies reported that only about half of patients with poor glycemic control (A1C $> 8\%$) had a dosage increase or change in therapy, the reasons for the lack of change in therapy have not been well documented.¹⁴⁻¹⁶

New oral medications provide additional options for treating patients with type 2 diabetes and delaying the addition of insulin to the treatment regimen. A survey conducted by Consumer Health Sciences and published in 1999 in *Diabetes Forecast* indicated that many patients (43%) think insulin is unnecessary and do not like the idea of using needles.¹⁷ Thus, the availability of new options for oral treatment combined with the reluctance of patients or providers to start insulin therapy may have a large impact on current antidiabetic therapy.

A large proportion of patients in our study did not have an A1C level documented in the 6 months after the index date, which may indicate either lack of monitoring of glycemic control or use of facilities or services not captured by the health plan. There also was low use of many agents (with only ~3% of patients receiving a thiazolidinedione or α -glucosidase inhibitor) in our population, which may have influenced the rates of glycemic control observed. Cohen et al similarly reported low use of agents in these drug classes.¹¹ However, use of insulin was lower in our study as well (approximately 4% overall, and 11% among users of antidiabetic medications during a 3-month period, compared with 18% during a 1-year period in the study by Cohen et al). Of note, Cohen et al reported decreasing use of insulin therapy from 1997 to 2000.¹¹

In another study evaluating use of medication for chronic disease in managed care and indemnity plans, Stafford et al reported that the prevalence of use of any

antidiabetic medication by patients who were diagnosed with type 1 or type 2 diabetes in managed care settings during calendar year 1997 was 75% among patients younger than age 65 years and 67% among patients age 65 years or older.¹⁸ The rate of medication use may have been higher in that study than in ours because medication use was measured over 12 months as opposed to 3 months in our study, in addition to the fact that patients with a diagnosis of type 1 diabetes were included in the study population.

A preliminary report based on 1999-2000 NHANES data found that approximately 16% of patients with diagnosed type 2 diabetes used insulin monotherapy, 11% used insulin and an oral antidiabetic medication(s), and 53% used oral agents only⁶; however, the NHANES 1999-2000 data were based on the self-reports of a small (n = 372) number of diabetes patients. In addition, the investigators excluded subjects for whom information on the type of medication or duration of diabetes was missing. Thus, methodological differences—including the study populations, observation periods, and methods used to identify patients and drug exposures—likely account for the differences in drug utilization patterns observed in published studies. Although nonadherence to medications may have affected our estimates of the prevalence of medication use, the evaluation of dispensed therapy may be less likely to result in exposure misclassification than self-report of medication therapy or documented prescribing in the medical record because only patients who are dispensed medication are considered “medication-treated” patients.

CONCLUSION

In this report, we emphasized glycemic control in patients receiving medication therapy because patients receiving antidiabetic medication therapy may be dissimilar to patients not receiving medication therapy in a number of ways. For example, patients receiving medication therapy may be evaluated more frequently than those not receiving therapy, resulting in less reliable measurement of A1C for patients not receiving medication therapy. In our study, a large proportion of those not receiving medication (68%) did not have an A1C test performed in the 6 months after the index date, although like medication-treated patients, most (93%) had at least 1 office visit related to diabetes in the preceding year.

It also is important to note that this observational study does not suggest that adding additional antidiabetic medications to a patient's prescription regimen is an ineffective strategy. We found that patients with uncontrolled diabetes were more likely to be prescribed more

medications, perhaps because multiple medications are an indicator of more severe diabetes. Randomized trials are needed to further explore when and how multiple antidiabetic medications should be combined, as well as when insulin therapy should be initiated.

Glycemic control rates were low in this patient population, and the same has been observed in many other US studies. Optimal glycemic control remains elusive for many diabetic patients despite the recent introduction of several new oral antidiabetic medications. Glycemic control was particularly poor among patients receiving multiple oral agents: only 13% of patients receiving 3 or more oral agents had optimal glycemic control. Thus, our data suggest that patients receiving multiple antidiabetic agents are an important group for health plans to identify and target for interventions, particularly where access to laboratory test results is limited or unavailable. Increased efforts by health plans, as well as by healthcare professionals, appear necessary to treat these patients to goal.

REFERENCES

- Boyle JP, Honeycutt AA, Narayan KM, et al. Projection of diabetes burden through 2050: impact of changing demography and disease prevalence in the US. *Diabetes Care*. 2001;24:1936-1940.
- American Diabetes Association. Economic costs of diabetes in the US in 2002. *Diabetes Care*. 2003;26:917-932.
- Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications of insulin-dependent diabetes mellitus. *N Engl J Med*. 1993;329:977-986.
- UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998;352:837-853.
- American Diabetes Association. Standards of medical care in diabetes. *Diabetes Care*. 2005;28(suppl 1):S4-S36.
- Koro CE, Bowlin SJ, Bourgeois N, Fedder DO. Glycemic control from 1988 to 2000 among US adults diagnosed with type 2 diabetes: a preliminary report. *Diabetes Care*. 2004;27:17-20.
- Karter AJ, Moffet HH, Liu J, et al. Achieving good glycemic control: initiation of new antihyperglycemic therapies in patients with type 2 diabetes from the Kaiser Permanente Northern California diabetes registry. *Am J Manag Care*. 2005;11:262-270.
- Skylar JS, Oddo C. Diabetes trends in the USA. *Diabetes Metab Res Rev*. 2002;18(suppl 3):S21-S26.
- Clark DO, Von Korff M, Saunders K, Baluch WM, Simon GE. A chronic disease score with empirically derived weights. *Med Care*. 1995;33:783-795.
- Putnam KG, Buist DS, Fishman P, et al. Chronic disease score as a predictor of hospitalization. *Epidemiology*. 2002;13:340-346.
- Cohen FJ, Neslusan CA, Conklin JE, Song X. Recent antihyperglycemic prescribing trends for US privately insured patients with type 2 diabetes. *Diabetes Care*. 2003;26:1847-1851.
- Benoit SR, Fleming R, Philis-Tsimikas A, Ji M. Predictors of glycemic control among patients with type 2 diabetes: a longitudinal study. *BMC Public Health*. 2005;5:36.
- Kogut SJ, Andrade SE, Willey C, Larrat EP. Nonadherence as a predictor of antidiabetic drug therapy intensification (augmentation). *Pharmacoepidemiol Drug Saf*. 2004;13:591-598.
- Grant RW, Cagliero E, Dubey AK, et al. Clinical inertia in the management of type 2 diabetes metabolic risk factors. *Diabetes Med*. 2004;21:150-155.
- Shah BR, Hux JE, Laupacis A, Zinman B, van Walraven C. Clinical inertia in response to inadequate glycemic control. *Diabetes Care*. 2005;28:600-606.
- Wetzler HP, Snyder JW. Linking pharmacy and laboratory data to assess the appropriateness of care in patients with diabetes. *Diabetes Care*. 2000;23:1637-1641.
- The stats on diabetes and drugs. *Diabetes Forecast*. January 1999;52:40.
- Stafford RS, Davidson SM, Davidson H, Miracle-McMahill H, Crawford SL, Blumenthal D. Chronic disease medication use in managed care and indemnity insurance plans. *Health Serv Res*. 2003;38:595-612.